

METHOD AND DEVICE FOR MONITORING THE STATE OF VEHICLE
CHASSIS

The invention relates to a method and a device for monitoring the state of vehicle chassis. The invention is suitable for use in rail vehicles but is not restricted to this.

Maintenance costs of rail vehicles and especially of their chassis represent a considerable fraction of the operating costs. Since it has hitherto not generally been possible to assess the actual state of chassis components of rail vehicles affected by wear or subjected to ageing process in the built-in state, testing and maintenance measures are usually carried out at fixed intervals which are associated with at least partial dismantling of the chassis. The maintenance intervals are selected to be so short that any damage or deterioration in the state of a chassis element which occurs in the meantime, does not yet result in a critical state. This has the consequence that an appreciable proportion of the work is carried out prematurely or a considerable proportion of the relevant chassis elements are replaced although no deterioration in their state has occurred.

A number of methods and devices are known for monitoring individual chassis components of rail vehicles.

A number of known solutions relate to the presence of wheel tyres or flanges. Such systems do not yield any prediction on the slowly changing state of a component but assess the instantaneous safety of the chassis system.

A number of other known solutions are restricted to measuring the vibrations or impacts in the chassis which occur during operation and only take into account the violation of pre-defined limits when making the assessment,

whether this be tolerable amplitudes or reference spectra. Here also only a "good" – "bad" discrimination is therefore made.

In some known solutions a sensor is attached to components which are considered to be particularly critical, which specifically monitors this chassis element. No correlation is therefore made between the measurements at various points of the chassis. No prediction of the remaining lifetime is deduced from the measurements.

The object of the invention is to eliminate the disadvantages of the prior art which have been described and to propose a method and a device for monitoring the state of vehicle chassis which makes it possible to continuously monitor the state of chassis components affected by wear or ageing and to make a reliable evaluation at any time. This forms the basis of a state-related inspection and maintenance regime. Great importance is attached to a minimum number of sensors required per chassis in order to keep the investment costs and also the operating or life cycle costs as low as possible. Here also, no monitoring of the chassis state is carried out with regard to possible causes for a certain chassis state.

This object is solved by a method for monitoring the state of vehicle chassis according to the features of claim 1 and a device for monitoring the state of vehicle chassis according to the features of claim 10.

According to the invention, physical variables are measured on the chassis by means of sensors. The measured and optionally processed variables are then compared with modelled variables by means of a first processing unit, wherein the modelled variables are determined from specific variables, for example, using the measured variables. From the comparison, a classification into classes of causes for possible deviations is made by means of a processing unit, for example, the first processing unit. As a result of the classification, an evaluation is then made.

It is hereby possible to continuously monitor the state of chassis components affected by wear or ageing and to make a reliable evaluation at any time. This can form the basis for a state-related inspection and maintenance regime.

The solution according to the invention makes it possible to use a minimal number of sensors per chassis so that, both, the investment costs of the monitoring system and its operating or life cycle costs can be kept as low as possible.

Compared with the prior art, on the basis of the signals from a minimum number of sensors, the solution according to the invention allows a comprehensive assessment of the state of the various components of a vehicle chassis equipped therewith, especially a rail vehicle, as well as a prediction of the future development of this state. A state-related planning of maintenance measures is thereby possible which avoids numerous superfluous and prematurely taken measures caused by a maintenance regime with fixed deadlines.

The physical variables may be any suitable variables from which the state of a vehicle component may be concluded. Speeds, accelerations and/or forces are preferably measured as physical variables.

Preferably, the processing unit comprises a model of the vehicle which continuously identifies the parameters of the vehicle and continuously compiles a simulatory prognosis of the vehicle behaviour. Additionally or alternatively, the processing unit comprises one or more damage evolution or ageing models of vehicle components with which the remaining lifetime before reaching a critical state or before a necessary maintenance measure is determined or updated.

The comparison of the measured variables and the modelled variables, eventually after processing, is preferably made by means of a correlation. For this purpose, suitable correlation methods or correlation algorithms are used,

for example, by which means information can be derived from various values to be processed.

The classification is preferably made by means of a suitable electronic processing unit, for example, by means of a computer. In this case, a classification can preferably be made as to whether a cause inside the vehicle or an external cause is involved. Furthermore, a classification is preferably made as to the location of the cause involved inside the vehicle.

The modelled variables can basically be determined in any suitable fashion. Thus, for example, corresponding tables can be provided, for example, stored, by which the modelled variables are determined. However, the modelled variables are preferably calculated using corresponding calculation algorithms.

The present invention further relates to a device for monitoring the state of vehicle chassis which is especially suitable for applying the method according to the invention. According to the invention, the device has one or more sensors to measure physical variables on the chassis. It further comprises a processing unit for calculating modelled variables, a processing unit for comparing the measured and eventually processed variables with modelled variables, a processing unit for classification as the result of the comparison and means for the evaluation. In this case, separate processing units may be provided. However, all the functions may also be made available by a single processing unit.

The advantages and variants of the method according to the invention described above can be achieved to the same extent using this device so that reference is merely made here to the explanations given above.

Preferably, the processing unit comprises the model of the chassis which continuously identifies its parameters and by this means continuously compiles a simulatory prognosis of the chassis behaviour. Additionally or alternatively, the processing unit also comprises damage evolution or ageing

models of chassis components with which the remaining lifetime before reaching a critical state or before a necessary maintenance measure can be determined or updated.

In further preferred variants of the device according to the invention it is provided that an interface to a superordinate vehicle control system is connected to the processing unit via which data on the actual driving state, for example, the speed of travel, can be delivered to the processing unit. Likewise, messages of the processing unit can be transmitted via the interface to a suitable memory and stored there. Likewise such messages of the processing unit can be transmitted to the driver or traction unit conductor or to any external control centre.

It is preferably provided that the means for evaluation is a signalling device inside the vehicle and, additionally or alternatively, a signalling device in a mobile or stationary control centre outside the vehicle including a data transmission device from the vehicle to the control centre.

Further preferred embodiments of the invention are obtained from the dependent claims or the following description of a preferred exemplary embodiment which refers to the enclosed drawings. It is shown in:

Figure 1 a schematic diagram of a preferred embodiment of the method according to the invention for a rail vehicle;

Figure 2 a schematic diagram of a further preferred embodiment of the device according to the invention.

The method according to the invention is based on a model 1 of the chassis of the rail vehicle including any active components which may be present and on correlation methods or algorithms 2 for deriving information from various measured values 3 or values 4 delivered by the superordinate control system. Thus, on the basis of the sensor data as well as the driving state of the

vehicle, its behaviour is continuously predicted in a simulatory fashion in block 5 and this prognosis is output in block 7.

Deviations of the actual behaviour determined in block 6 from this prognosis are identified early in block 8 and, using the model 1, the causative component is identified in block 9 and its state is determined or the cause is classified, respectively, in block 10. Together with a model 11 of the deviation or damage evolution, the remaining lifetime of the identified causative component is determined in block 12. It is then decided in block 13 whether operating restrictions represented in block 14 are taken and when which maintenance measures, represented in block 15, must be taken.

In an advantageous embodiment the device according to the invention comprises a number of sensors 21, 22 attached at suitable positions in the chassis of a rail vehicle, which may eventually be an integrated component of the active elements 23 in the chassis.

Further, the device comprises an electronic processing unit 24 connected to the sensors 21, 22 which

- comprises a unit 25 containing the model 1 of the chassis wherein the parameters of the chassis are continuously identified by means of the model 1 and a simulatory prognosis 5 of the chassis behaviour is compiled
- and
- comprises a unit 26 containing the damage evolution or ageing models 11 of chassis components and thereby determines and updates, respectively, the remaining lifetime 12 before a critical state is reached or before a necessary maintenance measure, respectively.

In an advantageous embodiment, the device according to the invention further comprises a connection to a superordinate control system 27 of the rail vehicle via which data on the actual driving state 4, e.g., the speed of travel,

can be delivered to the device according to the invention or messages therefrom can be saved in a memory 28 provided for this purpose and can be transmitted to the driver or traction unit conductor 29 or an external control centre 30.

The model 1 used for the assessment and prediction of the state can preferably be a component of the integrated controller concept 16 for the active components 23 of the chassis within which the decision on the tolerability of the remaining lifetime and the measures to be taken from block 13 is taken.

The sensor 21 in the present case is a vibration sensor which is arranged on a bogie whereas the sensor 22 is a force sensor which is arranged on a drive 23 of the rail vehicle.

It is understood that in other variants of the invention, other sensors can be provided at other suitable positions of the vehicle which make it possible to obtain reliable predictions on the state of certain components of the vehicle.

REFERENCE LIST

- 1 Software model of the chassis
- 2 Correlation methods or algorithms
- 3 Physical variables measured by sensors
- 4 Information delivered from vehicle control system
- 5 Simulation for predicting chassis behaviour
- 6 Data describing the actual chassis behaviour
- 7 Prediction of the chassis behaviour compiled by simulation
- 8 Identification of deviations between predicted and actual chassis behaviour
- 9 Identification of the chassis component causing the deviation
- 10 Determination of the actual state of the chassis component causing the deviation
- 11 Model of the deviation evolution or of the ageing and/or damage evolution of chassis components
- 12 Remaining lifetime of the chassis component being considered
- 13 Decision on the tolerability of the remaining lifetime which has been determined and on the measures to be taken
- 14 Operating restrictions
- 15 Required maintenance measures
- 21 Sensors attached in the chassis
- 22 Sensors integrated in active chassis components
- 23 Active elements or systems in the chassis
- 24 Electronic processing unit
- 25 Software model of the chassis
- 26 Model of the deviation evolution or of the ageing and/or damage evolution of chassis components

- 27 Vehicle control system
- 28 Memory for messages connected to the control system or integrated therein
- 29 Message device for the driver or traction unit conductor, e.g. display
- 30 Device for transmitting messages to a control centre